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In re the application of: **Ruth Sarah Daly**

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For: **Method and Sytem for Incremental Actions Relating to Notify and Target Models**

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ENCLOSURES *(check all that apply)*

☐	Amendment/Reply	☐	Assignment and Recordation Cover Sheet	☐	After Allowance Communication to Group
	☐ After Final	☐	Part B-Issue Fee Transmittal	☐	Notice of Appeal
☐	Information disclosure statement	☐	Letter to Draftsman	☐	Appeal Brief
	☐ Form 1449	☐	Drawings	☐	Status Letter
	☐ (X) Copies of References	☐	Petition	■	Postcard
☐	Extension of Time Request *	☐	Fee Address Indication Form	☐	Other Enclosure(s) (*please identify below):*
☐	Express Abandonment	☐	Terminal Disclaimer		
■	Certified Copy of Priority Doc - Canadian Serial No. 2,340,472	☐	Power of Attorney and Revocation of Prior Powers		
☐	Response to Incomplete Appln	☐	Change of Correspondence Address		
☐	Response to Missing Parts	*Extension of Term: Pursuant to 37 CFR 1.136, Applicant petitions the Commissioner to extend the time for response for xxxxxx month(s), from to .			
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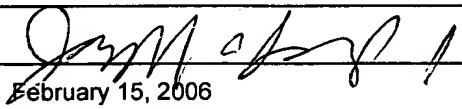
Signature	
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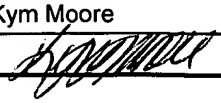
Signature	

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Specification and Drawings as originally filed, with Application for Patent Serial No: **2,340,472**, on March 12, 2001, by **IBM CANADA LIMITED - IBM CANADA LIMITÉE,** assignee of Ruth S. Daly, for "Incremental Actions Relating to Notify and Target Models ".

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INCREMENTAL ACTIONS RELATING TO NOTIFY AND TARGET MODELS

Abstract

Embodiments of the invention provide for an action to be performed on a target model based on changes in the notify model. The difference between this, and the previous examples, is that in the previous examples, the actions are performed against the notify model, not the target model. When an action needs to be performed based on a change in the target model, the previous examples of behavior are inadequate. Because the target model does not notify that it has been changed, a correlation between the notify model and target model will be used to determine what has changed in the target model. Given that the notify model and the target model are representations of the same data, if the notify model sends an event notification (which indicates that a change has occurred in the notify model), it can be deduced that the corresponding item in the target model has been changed, too. Based on the changes made in the notify model, and using a mapping of the linkages associating objects in the notify model to objects in the target model, the objects in the target model affected by the changes in the notify model are identified. The action (e.g., a validation check) is performed only on the changed parts of the target model.

INCREMENTAL ACTIONS RELATING TO NOTIFY AND TARGET MODELS

Field of the Invention

The present invention relates to incremental actions relating to notify and target models and, more particularly, to a method and system of incremental actions relating to notify and target models.

Background to the Invention

Computer applications continue to play an increasingly important role in the lives of individuals. Additionally, the desire by end-users for bigger, better and faster applications has also increased.

Unfortunately for application development teams, the applications have increased in complexity. As a result of this complexity, the time to develop applications has also increased. The demand for bigger, better and faster applications is often combined with the requirement that these new applications be provided to the market in ever shorter time frames.

As will be apparent, the market forces to develop bigger, better and faster applications in ever shorter times is in direct competition with the development teams' need for longer times to develop these same applications. Accordingly, tools to assist a developer or development teams in shortening the development cycle are desired.

In the present development environment, different models often represent the same data but in different formats. A model may be a collection of objects. The objects may, or may not, be of the same type.

For an example of the same data in different formats, consider the source code of an

application under development. The source code, which forms a source object, is sometimes represented in two models: a model of files, and a model of objects. The data contained in the file is the same data that is contained in the object. To be specific, because the source file is code, each object, in the model of objects, is a *metadata* object. In information technology, the prefix "meta" often means "a description of". metadata is a description of data; and in this example, metadata would name the parts of the source code: fields, methods, etc. Fields and methods are defined in the following paragraph.

In object oriented programming, an object often models a "real life" entity. For example, an object may be created to describe a rectangle. Variables or "fields" are identified to represent characteristics of all rectangles, namely the length and width. Procedures (known in the art as methods) would be present in the object to manipulate the length and width to generate other characteristics such as perimeter and area of a rectangle.

A model may comprise many different source code files. In fact, it is not uncommon for complex applications to comprise several million lines of source code distributed among thousands of separate files. Each source code file may describe several objects.

For the purpose of this document, "notify model" is used to represent a model(s) which, when changed, results in a signal, known as an "event notification", being issued which indicates that a change has occurred. "Target model" is used to represent a model(s) which, when a change has occurred in the notify model, either changes in response to that change, or is changed concurrently with the notify model change. As will be appreciated, the notification of a change only operates in one direction from the notify model to the target model.

It is known to those skilled in the art that programming code can be written, especially in object-oriented languages, to receive event notifications (i.e., the programming code is notified when certain changes occur).

Depending on the context, both source models and object models can be either a notify model, or a target model. To assist in the understanding of the notify and target models, the following examples illustrate three scenarios. In the first exemplary scenario, a file in the source model is changed and an object model is modified in response to the file change. In this first exemplary scenario the source model is the notify model, and the object model is the target model. In a second exemplary scenario a developer's tool changes an object model which causes new source code files to be created. In this second exemplary scenario the object model is the notify model, and the source model is the target model. In a third exemplary scenario source code is used as input for a tool. The tool generates new source code files, and, due to the existence of new code, an object model is updated. In this third exemplary scenario, the source code is both a notify and target model, and the object model is a target model.

As will be appreciated, a single instance of a notify model may consist of several models. Similarly, an instance of a target model may also consist of several models.

The notify and target model is exemplified in the use of computer code generators. Many applications presently exist to assist developers in generating code which, for many functions, is relatively easy to complete but quite time consuming to code and test. As a result of the laborious nature of producing some code, automatic code generators have been created. These automatic code generators, which often use a visual representation, or model, of the desired output, generate code which represents the graphical model produced.

For example, writing computer code for a graphical user interface (GUI), such as those common to most users of the Microsoft Windows operating system, is quite time consuming. To assist developers in generating the code for a GUI, automatic code generators have been created. These GUI code generators allow developers to work in a graphical development environment and select various user interface controls (e.g., radio buttons, drop down list boxes, selection boxes, etc.), typically using a "drag and drop" mechanism, and place the user interface controls in the graphical development environment representing a screen image to be presented to a user. When the developer

has completed the graphical appearance, the developer instructs the development environment to generate the code which will implement the graphical representation created. In this example, the graphical representation of the user interface interacts with the object notify model, and the code automatically generated is the target mode). The automatic generation of code may be initiated by developer/user command (by, for example, selecting a menu item) or automatically when the developer saves the file -- storing the graphical/notify model of the user interface. As can be appreciated, changes in the notify model (as represented by the graphical user interface, in this example) results in those changes being propagated to the target model (the actual computer source code for the user interface).

A further example of a notify model and a target model is the use of code generators with Enterprise JavaBeans™ ("EJB"). In this example, an EJB is created and forms part of a notify model. An automatic code generator, applied to the EJB, generates source code objects for the particular environment for which the source code is being deployed. These source code objects form the target model.

Development tools, such as automatic code generators, enable developers to spend more time on the functions which differentiate their applications from their competitors and less time writing code for common and relatively standard user interface attributes.

Additionally, it is common in the development environment to perform tests against the notify model or the target model to ensure compliance of the application under development with various requirements. These requirements may include, for example, compliance with specifications (such as industry standards), naming conventions, as well as many others. Ensuring compliance with a specification is often referred to as validating the code.

Presently, when a change in a notify model is completed, testing of the model (e.g., validating source code or the EJB in the examples described above, respectively) is conducted against the complete target model. Additionally, testing of the target model (e.g., validation of an object model)

is commenced by user command. As will be appreciated, this can be extremely time consuming. Additionally, the user may fail to invoke the testing of the target model. As a result, testing of the code is often delayed to the end of the development cycle. Delaying testing often results in defects which could have been rectified earlier in the development cycle being identified late in the development cycle. Unfortunately, additional code which may have been developed in the interim and, if that additional code depends on the defects in the original code, the problem is exacerbated.

Accordingly, development tools which address some of the difficulties in application development are desired.

Summary of the Invention

Embodiments of the invention provide for an action to be performed on a target model based on changes in the notify model. The difference between this, and the previous examples, is that in the previous examples, the actions are performed against the notify model, not the target model. When an action needs to be performed based on a change in the target model, the previous examples of behavior are inadequate. Because the target model does not notify that it has been changed, a correlation between the notify model and target model will be used to determine what has changed in the target model. Given that the notify model and the target model are representations of the same data, if the notify model sends an event notification (which indicates that a change has occurred in the notify model), it can be deduced that the corresponding item in the target model has been changed, too.

Based on the changes made in the notify model, and using a mapping of the linkages associating objects in the notify model to objects in the target model, the objects in the target model affected by the changes in the notify model are identified. The action (e.g., a validation check) is performed only on the changed parts of the target model.

Advantageously, the incremental nature of this action identifies problems sooner, because

the action can be run more often, since, given less input, it will not take as much time to complete. When problems are identified sooner, there is less opportunity for other code to become dependent on faulty behavior, and thus less chance that the fix for the faulty behavior will break other code. Consequently, this incremental nature of the action performed results in reduced testing time and thus increases the efficiency of a developer or a development team.

Embodiments of the invention generate a map which correlates a portion of the notify model to a portion of the target model.

In one aspect of the invention there is provided a computer system for performing an action on a target model, wherein said target model is associated with a notify model, said target model comprising target objects and said notify model comprising notify objects, said computer system comprising: a model map mapping said notify objects of said notify model to associated target objects in said target model; an action operator adapted to perform said action on objects in said target model; and wherein, responsive to modification of a selected notify object in said notify model, said action operator performing said action on an identified target object associated with said selected notify object, said identified target object determined with reference to said model map.

In a further aspect of the invention there is provided a method for performing for an action on a target model, wherein said target model is associated with a notify model, said target model comprising target objects and said notify model comprising notify objects, said method comprising: mapping said notify objects of said notify model to associated target objects in said target model; responsive to modification of a selected notify object in said notify model, performing said action on an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

In a further aspect of the invention there is provided a computer readable medium storing data and instructions adapting a computer system to: map notify objects forming a notify model to associated target objects in a target model; responsive to modification of a selected notify object in

said notify model, performing an action on an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

In a further aspect of the invention there is provided a data signal carrier carrying computer data and instructions adapting a computer system to: map notify objects forming a notify model to associated target objects in a target model; responsive to modification of a selected notify object in said notify model, performing an action on an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

In a further aspect of the invention there is provided a source code validator for validating source code forming a target object in target model, said target model comprising a plurality of target objects, said target model associated with a notify model wherein notify objects comprising said notify model are associated with one or more target objects in said target model and wherein modifications to a notify object in said notify model are propagated to one or more target objects in said target model, said source code validator adapted to, responsive to modification of a selected notify object in said notify model, perform code validation on an identified target object associated with said selected notify object, said identified target object determined with reference to a map of the associations between said notify objects in said notify model and the target objects in said object model.

In a further aspect of the invention there is provided a method for performing for an action on at least one of a target model and a notify model, wherein said target model is associated with said notify model, said target model comprising target objects and said notify model comprising notify objects, said method comprising: mapping said notify objects of said notify model to associated target objects in said target model; responsive to modification of a selected notify object in said notify model, performing said action on at least one of said selected notify object and an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

Brief Description of the Drawings

FIG. 1 schematically illustrates a computer system embodying aspects of the invention;

FIG. 2 schematically illustrates, in greater detail, a portion of the computer system of FIG. 1;

FIG. 3 illustrates, in functional block form, a portion of FIG. 2;

FIG. 4 is a flowchart of exemplary operations of the computer system of FIG. 1;

FIG. 5 is a further flowchart of exemplary operations of the computer system of FIG. 1; and

FIG. 6 is a flowchart of alternative and exemplary operations of the computer system of FIG. 1.

Detailed Description of Embodiments of the Invention

An embodiment of the invention, computer system 100, is illustrated in FIG.1. Computer system 100, illustrated for exemplary purposes as a networked computing device, is in communication with other networked computing devices (not shown) via network 110. As will be appreciated by those of ordinary skill in the art, network 110 may be embodied using conventional networking technologies and may include one or more of the following: local area networks, wide area networks, intranets, public Internet and the like.

Throughout the description herein, an embodiment of the invention is illustrated with aspects of the invention embodied solely on computer system 100. As will be appreciated by those of ordinary skill in the art, aspects of the invention may be distributed amongst one or more networked

computing devices which interact with computer system 100 via one or more data networks such as, for example, network 110. However, for ease of understanding, aspects of the invention have been embodied in a single computing device - computer system 100.

Computer system 100 includes processing system 102 which communicates with various input devices 104, output devices 106 and network 110. Input devices 104, two of which are shown, may include, for example, a keyboard, a mouse, a scanner, an imaging system (e.g., a camera, etc.) or the like. Similarly, output devices 106 (only one of which is illustrated) may include displays, information display unit printers and the like. Additionally, combination input/output (I/O) devices may also be in communication with processing system 102. Examples of conventional I/O devices include removable and fixed recordable computer readable media (e.g., floppy disk drives, tape drives, CD-ROM drives, DVD-RW drives, etc.), touch screen displays and the like. Computer readable media may be local to computer system 100 or remote (and accessed via network 110).

Exemplary processing system 102 is illustrated in greater detail in FIG. 2. As illustrated, processing system 102 includes several components - central processing unit (CPU) 202, memory 204, network interface (I/F) 208 and I/O I/F 210. Each component is in communication with the other components via a suitable communications bus 206 as required.

CPU 202 is a processing unit, such as an Intel Pentium™, IBM PowerPC™, Sun Microsystems UltraSparc™ processor or the like, suitable for the operations described herein. As will be appreciated by those of ordinary skill in the art, other embodiments of processing system 102 could use alternative CPUs and may include embodiments in which one or more CPUs are employed. CPU 202 may include various support circuits to enable communication between itself and the other components of processing system 102.

Memory 204 includes both volatile and persistent memory for the storage of: operational instructions for execution by CPU 202, data registers, application storage and the like. Memory 204 preferably includes a combination of random access memory (RAM), read only memory (ROM) and

persistent memory such as that provided by a hard disk drive. The instructions stored by memory 204 may be received by computer system 100 as a data signal carrier from network 110.

Network I/F 208 enables communication between computer system 100 and other network computing devices (not shown) via network 110. Network I/F 208 may be embodied in one or more conventional communication devices. Examples of a conventional communication device include an Ethernet card, a token ring card, a modem or the like. Network I/F 208 may also enable the retrieval or transmission of instructions for execution by CPU 202 from or to a remote storage media or device via network 110.

I/O I/F 210 enables communication between processing system 102 and the various I/O devices 104, 106. I/O I/F 210 may include, for example, a video card for interfacing with an external display such as output device 106. Additionally, I/O I/F 210 may enable communication between processing system 102 and a removable media 212. Although removable media 212 is illustrated as a conventional diskette other removable memory devices such as Zip™ drives, flash cards, CD-ROMs, static memory devices and the like may also be employed. Removable media 212 (which may be local or remote to computer system 100) may be used to provide instructions for execution by CPU 202 or as a removable data storage device.

The computer instructions/applications stored in memory 204 and executed by CPU 202 (thus adapting the operation of computer system 100 as described herein) are illustrated in functional block form in FIG. 3. As will be appreciated by those of ordinary skill in the art, the delineation between aspects of the applications illustrated as functional blocks in FIG. 3 is somewhat arbitrary as the various operations attributed to a particular application as described herein may, in alternative embodiments, be subsumed by another application.

As illustrated, for exemplary purposes only, memory 204 stores operating system (OS) 302, communications suite 304, notify model 306, target model 308, model mapper 310, mapping lookup table 312 and model action operator 314.

OS 302 is an operating system suitable for operation with a selected CPU 202 and the operations described herein. Multitasking, multithreaded OSes such as, for example, IBM AIX™, Microsoft Windows NT™, Linux or the like, are expected in many embodiments to be preferred.

Communication suite 304 provides, through, interaction with OS 302 and network I/F 208 (FIG. 2), suitable communication protocols to enable communication with other networked computing devices via network 110 (FIG. 1). Communication suite 304 may include one or more of such protocols such as TCP/IP, ethernet, token ring and the like.

Notify model 306 and target model 308 are related and represent the same data but in different formats. The general characteristics of notify model 306 and target model 308 is that changes made to the objects of notify model 306 are propagated to the target model.

For ease of understanding many examples included in the remainder of this specification describe an embodiment in which the notify model is a graphical representation of a user interface created in a development environment such as the family of VisualAge® development products available from IBM Corporation. The target model 308 represents, in the exemplary embodiment, the source code files generated by the development environment based on the graphical/notify model 306 created by the developer. As such, changes made by the developer to the notify model 306 (e.g., adding/changing/deleting a new user interface element) may propagate changes to target model 308 when changes are saved by the developer.

Model mapper 310, which is preferably stored in a cache memory portion of memory 204 for quick retrieval, operates to collect, store and retrieve data which corresponds to the linkage between objects in notify model 306 and the corresponding objects in target model 308. The data corresponding to the linkages notify model 306 and target model 308 forms mapping lookup table 312. Mapping lookup table 312 could be implemented in alternative manners including, for example, a database.

The granularity of the linkage or mapping information collected by model mapper 310 may vary depending upon the environment in which embodiments of the present invention are deployed. For many embodiments, collecting linkage data describing the linkage between a single object in notify model 306 (e.g., a user interface screen) and the object(s) in the target model 308 (e.g., the source code file automatically generated by the code generator) may provide sufficient detail. In this embodiment, the event captured by model mapper 310 would simply describe the linkage between the object(s) in notify model 306 and the corresponding object (e.g., a source code file(s)) in target model 308.

However, in alternative embodiments, a more detailed level of granularity may be preferred. For example, assume that the source code generator outputs object oriented source code files based on the graphical user interface model created by the developer. A developer may only alter/create a small number of new user interface objects during editing. As a result, the source code automatically generated by the code generator may differ only slightly from the previous version of generated source code (i.e., a few files which did not exist before). The difference may be, for example, minor changes to only a few of the object constructs in the source code file which includes several hundred objects. Model mapper 310 may, similar to the previous embodiment, collect data relating to the linkage between the graphical model of the user interface (which forms part of the notify model 306) and the source code file generated (which forms part of the target model 308). Additionally, in this latter embodiment, model mapper 310 may also collect data which identifies the linkages between portions in the graphical representation in the notify model 306 and the corresponding individual object-oriented constructs which form part of the source code file in the target model 308.

Model action operator 314, which in the exemplary embodiment operates as a validator to ensure that the objects of notify model 306 (e.g., an EJB) comply with a particular standard, operates to perform a specified action on objects in the notify model 306.

Although not illustrated, an editor of the objects of target model 308 may also be provided.

The operations of the exemplary computer system 100 is described in greater detail with reference to FIGS. 4-5. FIGS. 4-5 provide flowcharts describing the operations of computer system 100 depicted as operations 400. FIG. 6 illustrates a flowchart of a detail of an alternative and exemplary operations of computer system 100.

Operations 400 are performed to generate mapping lookup table 312 as notify model 306 is modified. Initially, an object in notify model 306 (e.g., an EJB or a GUI screen) is created or modified by a user (S402). As a result of the modifications by the user, the changes in an object in notify model 306 are propagated to one or more objects forming target object 308 (S404). In some embodiments, the changes will not propagate to target model 308 until an indication to do so is made by the user. Such an indication may be made, for example, by the user saving or storing a modified object in notify model 306. As such several modifications to a single object in notify model 306 may be propagated contemporaneously to one or more objects in target model 308.

Model mapper 310 is notified of the changes to notify model 306 that are propagated to target model 308. The notification of model mapper 310 may be made by, for example, issuance of an event notification message (which may be generated or issued by, for example, the development environment - e.g., a VisualAge® product). The notification identifies the objects changed in notify model 306 and the corresponding changes in target model 308. For example, a single EJB may have been modified in notify model 306. This may result in several objects (e.g., several object classes) in target model 308 being similarly modified. Identity data describing the identify of both the single EJB in notify model 306 and the several objects (e.g., several object classes) in target model 308 will be collected by model mapper 310 and used to generate mapping lookup table 312.

Mapping lookup table 312 provides a notify model object - target model object correlation.

In alternative embodiments, finer granularity of the linkages between objects in notify model 306 and target model 308 could also be described by mapping lookup table 312. For example, model mapper 310, in addition to identity data collected which identifies objects modified in the notify and

target models 306, 308, could also collect additional data which correlates portions of objects modified in notify model 306 to the corresponding portions of objects in target model 308. For example, assume an object in notify model 306 represents an EJB which describes several methods. The EJB, when passed to a code generator, results in several (e.g., three) class objects being created. However, in this example the modification of a single method in the EJB results in a modification of a single method in one of the three class objects. A model mapper 310 which collects very detailed linkage data may populate mapping lookup table 312 with identity data (corresponding to the identity of the modified objects - the single EJB in the notify model 306 and the single class object in the target model) and data corresponding to the actual modifications made (e.g., the methods changed in each of the objects identified).

As a consequence of operations 400, mapping lookup table 312 is created which provides linkage data correlating the objects in notify model 306 to the objects in target model 308.

Operations 500 (FIG. 5) are performed by computer system 100 when an event notification is issued (by, for example, the development environment) which corresponds to the modification of the target model 308 only (i.e., a modification to target model 308 which is not the result of propagating changes from notify model 306). When an event notification indicating this condition is identified (S502), the model action operation 314 accesses mapping lookup table 312 to determine the object in notify model 306 which corresponds or is associated with the modified object in target 306 (S504). Once the associated object in notify model 306 has been determined, the proper action to be performed (e.g., identification of the proper specification for testing the EJB) is determined based on the object from notify model 306 identified (S506), and the action determined is performed (e.g., compliance with the identified specification) (S508).

As a consequence of operations 500 only those objects in notify model 306 which correspond to the modified objects in target model 306 will be operated on by model action operator 314. In the examples described above, this will result in only a limited number of the objects (e.g., EJBs) in notify model 306 being tested against the requisite specification. This incremental application of

action operator 314 (i.e., only applying the action, such as compliance testing, or code generation, to those target objects which have been altered) is in contrast to present systems which require a complete testing, or generation, or regeneration, of notify model 306 to be performed. The incremental application of action operator 314 to only those object in notify model 306 which are affected by changes to objects in target model 308 significantly improves the performance of the development environment.

An alternative embodiment to the operations 400 and 500 is illustrated in FIG. 6 as operations 600. In this alternative embodiment, mapping lookup table 312 is created only upon notification of an event describing a change in target model 308 (S602). Upon identification of a notification event, mapping lookup table 312 is created (S604). Mapping lookup table 312 can be created by traversing the objects in target model 308 to create a notify object - target object pair.

A traversal could be through links in objects, or through a list of files, etc. When traversing, given the current identifying item (e.g. an object, or a file), the developer, who understands the representations in the notify model(s) and target model(s), understands what part of the identifying item corresponds to which part of the target model. For example, the part could be the file itself; if it is a Java file, and that file contains the definition of a public class, then a developer who programs in Java knows that the name of the Java file is the name of the object. (This is a rule of Java.) Given that the developer understands the models, and the rules which pertain to each type of model, a relationship between the models can be deduced, and coded.

Once mapping lookup table 312 has been created, operations S606-S610, which are similar to operations S504-S508 (FIG. 5) and described above, are performed.

By operation of the above described embodiment of the invention improved validation of a target model could be performed. For example, assume model A stores information about employers and model B stores information about employees. Models A and B are not necessarily stored in the same location. Assume additionally that a model C stores information about companies and model

D stores information about persons. Models C and D are also not necessarily stored in the same location. In this example, models A and B form part of a notify model and models C and D form part of a target model.

If a change is made to an employer, say they hire 100 people, that will have an immediate effect on employee model B. The change in model B affects person model D. Embodiments of the invention (through the operation of mapping the linkage between the models and use the lookup table), will isolate the change from model B and perform whatever action is needed against model D. These operations provide improved performance as compared to those validation systems presently available.

In a further example of the exemplary embodiment if model A is changed because an employer is added this will affect company model C directly and employee model B (because a new company hires people). Embodiments of the invention can isolate what portion of model C is affected directly and those portions in model D that are also affected. The action performed (e.g., code validation) can then performed on those affected portions which, compared to other validation systems, results in improved validation performance.

In alternative embodiments, the mapping lookup table may be created, or retrieved, or retrieved and refreshed (for example, deletions do not require population), by an explicit action on the part of the user. For example, say that the user is interacting with a graphical user interface, and that the user presses a button on that interface. Instead of responding to an event change notification in the notify model, the mapping lookup table responds to the explicit action, and is populated, or retrieved, or retrieved and refreshed, based on the entire contents of the notify model/target model pairings. From then on, the incremental action could continue as explained before.

Alternatively, the mapping lookup table could be created in its entirety, either through an event notification, or through an explicit action done by the user. And when another event notification occurs, the existing model cache is retrieved, or retrieved and refreshed with the data (as

indicated by the event notification), and then the incremental action could continue as explained before.

The mapping lookup table may, in various embodiments, also be updated with linkage data upon the creation or modification of a notify model. Accordingly, in addition to performing an action on objects in the target model upon receipt of a notification event (e.g., validating portions of source code forming part of the target model), the mapping lookup table may also be update to reflect any changes in the linkage between the notify model and the target model.

Those of ordinary skill in the art will now appreciate that embodiments of the present invention may advantageously perform an action (e.g., validation) that is triggered automatically whenever a notify model has been modified. Additionally, and advantageously, embodiments of the invention perform the action only on those portions which have been modified. This advantages provide for a reduction in the time required to perform an action (e.g., validation). This provides improved performance while reducing the action (e.g., validation) input space.

As will be appreciated, the embodiments described herein could equally be applied to performing an action of the notify model rather than on the target model. However, it is believed that performing the required action against the target model will, in many embodiments, provide improved performance.

While one (or more) embodiment(s) of this invention has been illustrated in the accompanying drawings and described above, it will be evident to those skilled in the art that changes and modifications may be made therein without departing from the essence of this invention. All such modifications or variations are believed to be within the sphere and scope of the invention as defined by the claims appended hereto.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A computer system for performing an action on a target model, wherein said target model is associated with a notify model, said target model comprising target objects and said notify model comprising notify objects, said computer system comprising:

a model map mapping said notify objects of said notify model to associated target objects in said target model;

an action operator adapted to perform said action on objects in said target model; and

wherein, responsive to modification of a selected notify object in said notify model, said action operator performing said action on an identified target object associated with said selected notify object, said identified target object determined with reference to said model map.

2. The computer system of claim 1 wherein said notify model is a model of an object in an object oriented computer language and wherein said target model is source code associated with said object.

3. The computer system of claim 1 wherein said modification of a selected notify object generates an event notification signal and wherein said action operator performs said action responsive to receipt of said event notification signal.

4. The computer system of claim 1 wherein said model map is one of a lookup table and a database.

5. The computer system of claim 4 wherein said model map maps portions of said notify objects of said notify model to associated portions of said target objects in said target model.

6. The computer system of claim 5 wherein said action performed by said action operator is performed on identified portions of said target objects in said target model, said identified portions of target object determined with reference to said model map.

7. The computer system of claims 4 or 6 wherein said notify model is a model of an object in an object oriented language and wherein said target object is source code.

8. The computer system of claims 2 or 7 wherein said action performed is source code validation.

9. A method for performing for an action on a target model, wherein said target model is associated with a notify model, said target model comprising target objects and said notify model comprising notify objects, said method comprising:

mapping said notify objects of said notify model to associated target objects in said target model;

responsive to modification of a selected notify object in said notify model, performing said action on an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

10. The method of claim 9 wherein said mapping comprises collecting data corresponding to linkages between said notify objects and said target objects.

11. The method of claim 10 wherein said mapping further comprises storing said data collected in one of a lookup table and a database.

12. The method of claim 9 further comprising prior to said performing said action, receiving event notification data identifying said selected notify object.

13. The method of claim 10 wherein said reference to said mapping comprises retrieving from said mapping target identity data identifying said target object associated with said selected notify object.

14. The method of claim 9 wherein said mapping generates one of a lookup table and a database.

15. The method of claims 9-14 wherein said action performed on said identified target object comprises code validation.

16. A computer readable medium storing data and instructions adapting a computer system to:

map notify objects forming a notify model to associated target objects in a target model;

responsive to modification of a selected notify object in said notify model, performing an action on an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

17. The computer readable medium of claim 16 wherein mapping performed by said computer system comprises collecting data corresponding to linkages between said notify objects and said target objects.

18. The computer readable medium of claim 16 wherein mapping performed by said computer system further comprises storing said data collected in one of a lookup table and a database.

19. The computer readable medium of claim 16 further adapting said computer system to, prior to said performing said action, receiving event notification data identifying said selected notify object.

20. The computer readable medium of claim 16 wherein mapping performed by said computer system comprises retrieving from said mapping target identity data identifying said target object associated with said selected notify object.

21. The computer readable medium of claim 16 wherein said mapping generates one of a lookup table and a database.

22. The method of claims 16-20 wherein said action performed on said identified target object comprises code validation.

23. A data signal carrier carrying computer data and instructions adapting a computer system to:

map notify objects forming a notify model to associated target objects in a target model;

responsive to modification of a selected notify object in said notify model, performing an action on an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

24. The data signal carrier carrying computer data and instructions of claim 23 wherein said action performed by said computer system comprises performing code validation on said identified target object.

25. A source code validator for validating source code forming a target object in target model, said target model comprising a plurality of target objects, said target model associated with a notify model wherein notify objects comprising said notify model are associated with one or more target objects in said target model and wherein modifications to a notify object in said notify model are propagated to one or more target objects in said target model, said source code validator adapted to,

responsive to modification of a selected notify object in said notify model, perform code validation on an identified target object associated with said selected notify object, said identified target object determined with reference to a map of the associations between said notify objects in said notify model and the target objects in said object model.

26. The source code validator of claim 25 wherein said code validator is further adapted to:

collect and store data corresponding to linkages between said notify objects and said target objects in one of a lookup table and a database.

27. A method for performing for an action on at least one of a target model and a notify model, wherein said target model is associated with said notify model, said target model comprising target objects and said notify model comprising notify objects, said method comprising:

mapping said notify objects of said notify model to associated target objects in said target model;

responsive to modification of a selected notify object in said notify model, performing said action on at least one of said selected notify object and an identified target object associated with said selected notify object, said identified target object determined with reference to said mapping.

Figure 1

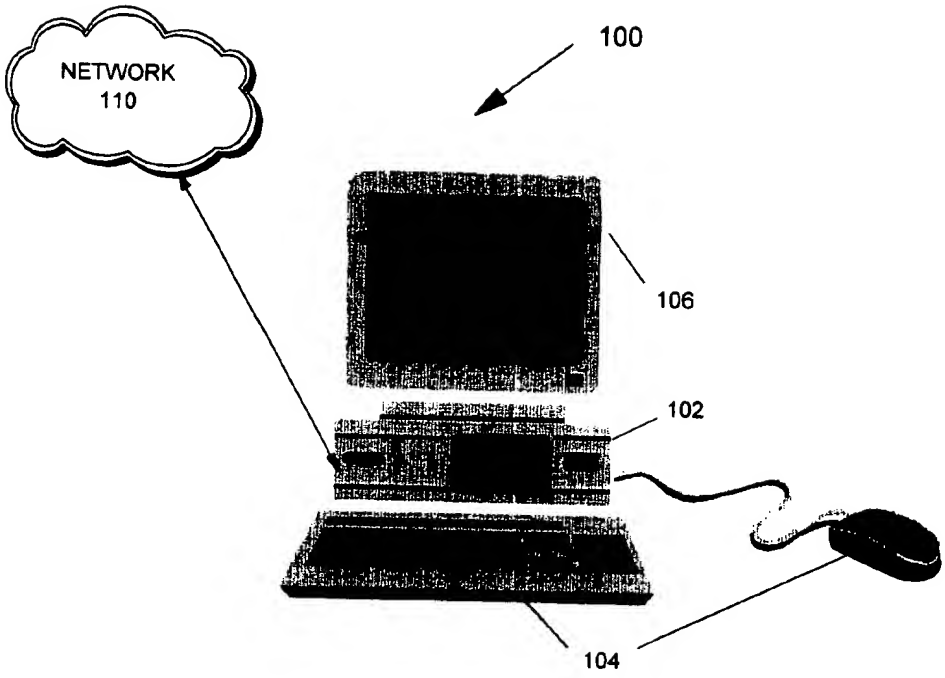


Figure 2

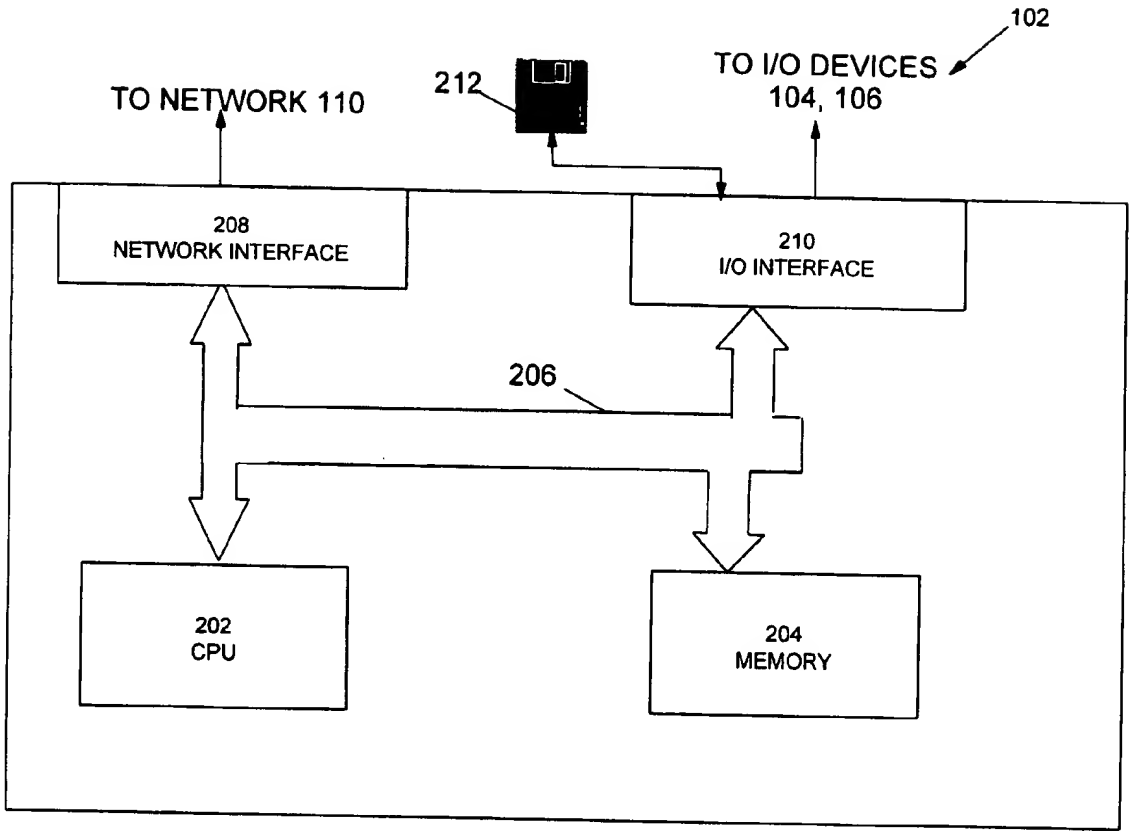

102
TO I/O DEVICES
104, 106
212
TO NETWORK 110
208
NETWORK INTERFACE
210
I/O INTERFACE
206
202
CPU
204
MEMORY

Figure 3

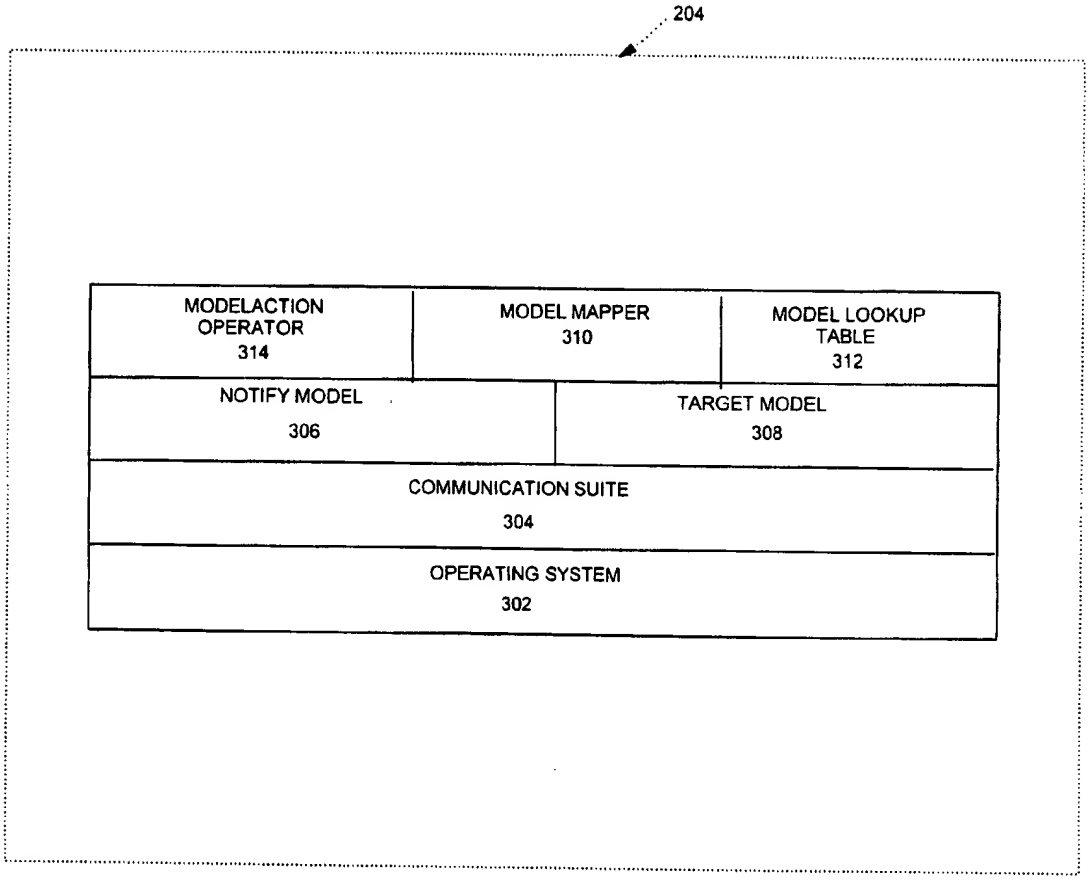

204
MODELACTION OPERATOR 314
MODEL MAPPER 310
MODEL LOOKUP TABLE 312
NOTIFY MODEL 306
TARGET MODEL 308
COMMUNICATION SUITE 304
OPERATING SYSTEM 302

Figure 4

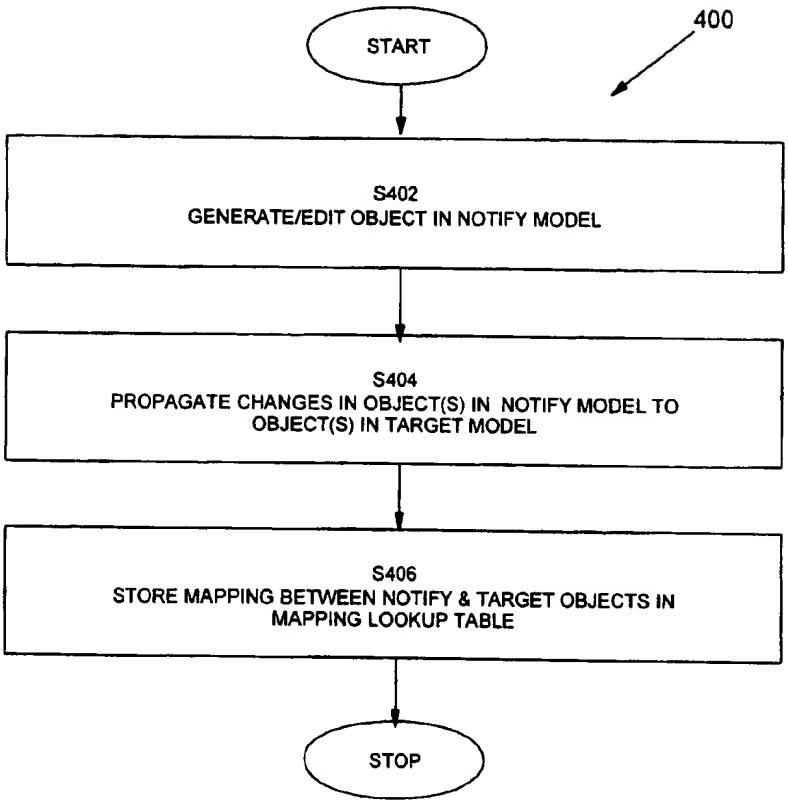

400
START
S402
GENERATE/EDIT OBJECT IN NOTIFY MODEL
S404
PROPAGATE CHANGES IN OBJECT(S) IN NOTIFY MODEL TO OBJECT(S) IN TARGET MODEL
S406
STORE MAPPING BETWEEN NOTIFY & TARGET OBJECTS IN MAPPING LOOKUP TABLE
STOP

Figure 5

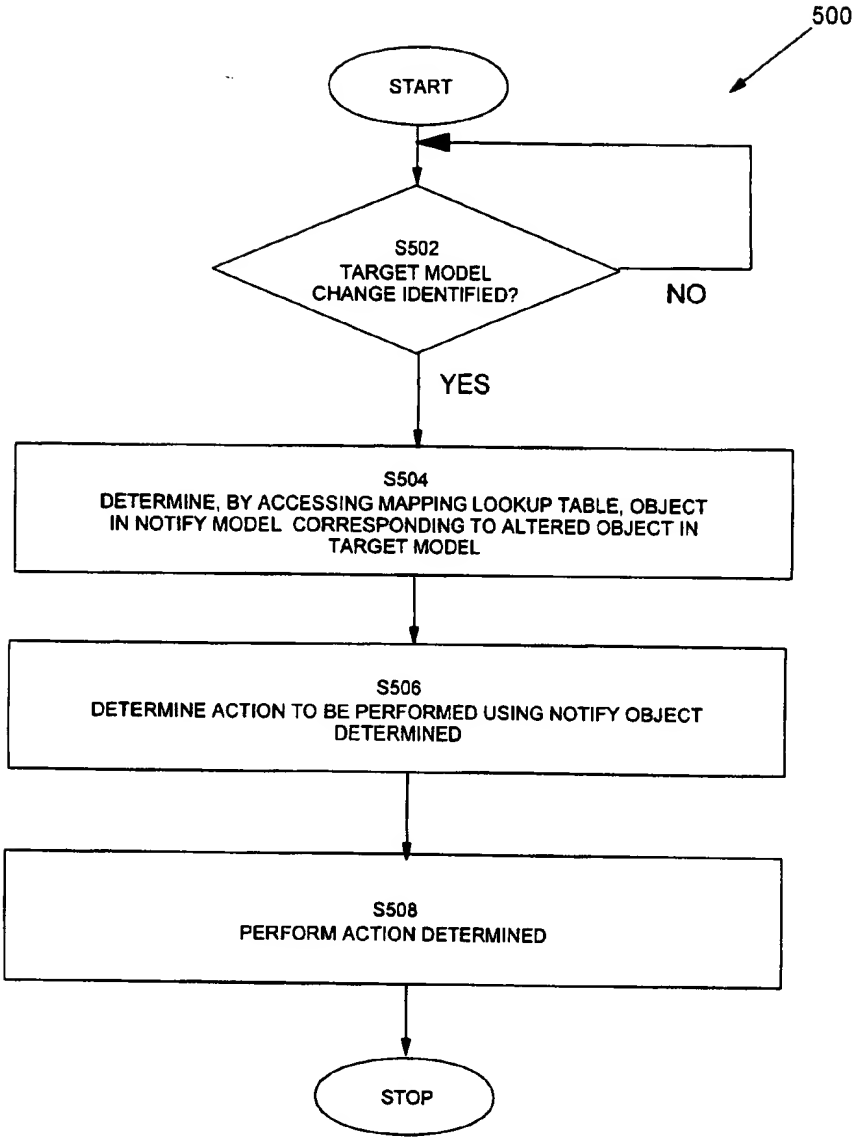
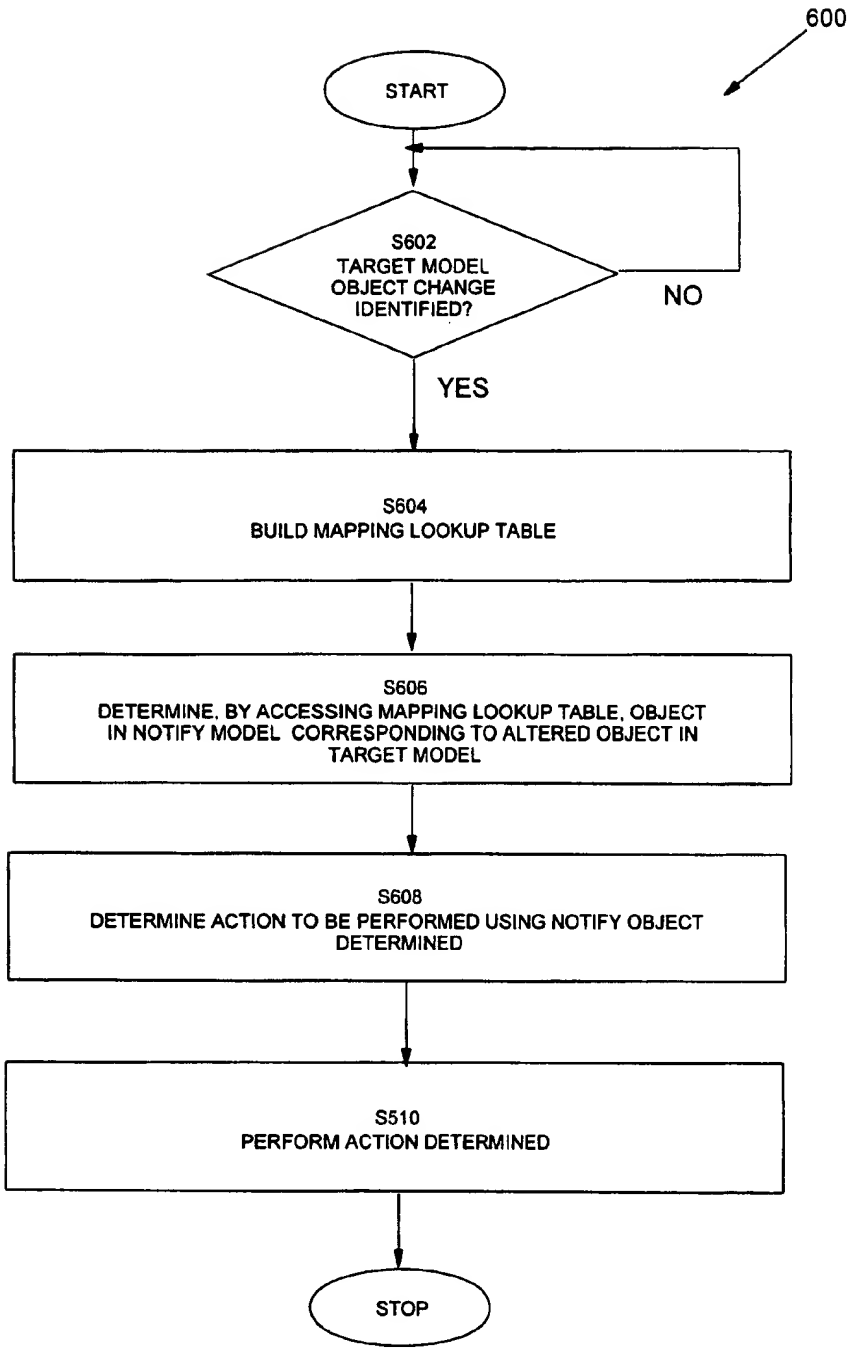

500
START
S502
TARGET MODEL
CHANGE IDENTIFIED?
NO
YES
S504
DETERMINE, BY ACCESSING MAPPING LOOKUP TABLE, OBJECT IN NOTIFY MODEL CORRESPONDING TO ALTERED OBJECT IN TARGET MODEL
S506
DETERMINE ACTION TO BE PERFORMED USING NOTIFY OBJECT DETERMINED
S508
PERFORM ACTION DETERMINED
STOP

Figure 6


600
START
S602
TARGET MODEL
OBJECT CHANGE
IDENTIFIED?
NO
YES
S604
BUILD MAPPING LOOKUP TABLE
S606
DETERMINE, BY ACCESSING MAPPING LOOKUP TABLE, OBJECT
IN NOTIFY MODEL CORRESPONDING TO ALTERED OBJECT IN
TARGET MODEL
S608
DETERMINE ACTION TO BE PERFORMED USING NOTIFY OBJECT
DETERMINED
S510
PERFORM ACTION DETERMINED
STOP

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